CLIPPEDIMAGE= JP408050998A

PAT-NO: JP408050998A

DOCUMENT-IDENTIFIER: JP 08050998 A

TITLE: PLASMA PROCESSING DEVICE

PUBN-DATE: February 20, 1996

INVENTOR-INFORMATION:
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HAMANO, KATSUTSUYA

INT-CL (IPC): H05H001/46;C23F004/00 ;H01L021/3065
;H01L021/31

ABSTRACT:

PURPOSE: To facilitate adjustment of each coil current as well as to increase flux density and to uniformalize the distribution of the flux density by composing a flat plate coil unit of plural coils.

CONSTITUTION: A plate coil unit 13 is composed by arranging plate coils 14, 15, 16, 17 on each of the fan shaped planes obtained by dividing a top plate 12 into four pieces and it is connected to a high frequency power supply 19 through a variable capacitor 18. In such a composition, the capacitance of a variable capacitor 18 is adjusted, an inductance value and the degree of plasma coupling are made adjustable by changing a current flowing through the coils 14-17, so that the uniformity of plasma in a vacuum container 10 is accomplished easily. Furthermore, the impedance is reduced by parallel connection of the coils so as to suppress the plasma oscillation caused by the impedance, thereby a stable and uniform high density plasma

can be obtained.

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Ｃ２３Ｆ　4/00	Ｇ	9352－4K		
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審査請求　未請求　請求項の数３　ＦＤ　（全 4 頁）　最終頁に続く

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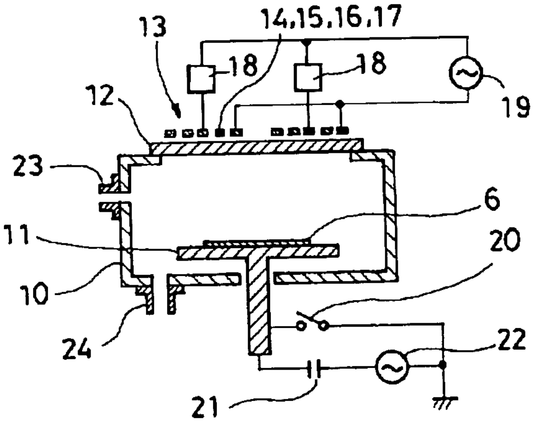
(74)代理人　弁理士　三好　祥二

(54)【発明の名称】　プラズマ処理装置

(57)【要約】

【目的】誘導結合方式のプラズマ処理装置に於いて均一な高密度プラズマを得る。

【構成】被処理物６に対向配置された平板コイルユニット１３に高周波電力を印加してプラズマを生成し、該プラズマを利用して前記被処理物を処理するプラズマ処理装置に於いて、前記平板コイルユニットを複数のコイル１４，１５，１６，１７で構成し、或は更に複数のコイルそれぞれに電流調整手段１８を接続し、或は更に複数のコイルを高周波電源に対して並列接続したものであり、平板コイルユニットを複数のコイルで構成することでインピーダンスを大きくすることなく磁束密度を高めることができ、更に磁束密度分布の均一化が図れ、更に各コイルそれぞれに流れる電流調整が可能となり、各コイル毎の磁束発生状態の調整が可能で均一な高密度プラズマを容易に得ることができる。



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【特許請求の範囲】

【請求項１】　被処理物に対向配置された平板コイルユニットに高周波電力を印加してプラズマを生成し、該プラズマを利用して前記被処理物を処理するプラズマ処理装置に於いて、前記平板コイルユニットを複数のコイルで構成したことを特徴とするプラズマ処理装置。

【請求項２】　複数のコイルそれぞれに電流調整手段を接続した請求項１のプラズマ処理装置。

【請求項３】　複数のコイルを高周波電源に対して並列接続した請求項１のプラズマ処理装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は高周波電力を誘導結合によって供給し、プラズマを発生させ、そのプラズマを利用して半導体素子の製造を行うプラズマ処理装置に関するものである。

【０００２】

【従来の技術】真空容器に高周波電力を供給して、プラズマを発生させプラズマにエネルギを与えるには静電容量結合方式と誘導結合方式とがある。近年半導体製造装置及びＬＣＤ装置等プラズマを用いて処理する装置に大幅な処理能力が求められる様になり、発生するプラズマの高密度が要求されている。

【０００３】前掲した静電結合方式のプラズマ処理装置の典型的な構成は、対峙配設された平行平板電極間に高周波電力を印加するものであり、平行平板電極間に形成されるプラズマでは高周波電界によってプラズマ中の高エネルギのイオン及び電子が被処理物上に到達する為、被処理物に損傷を与えるのみばかりか電極からの汚染も免れ得ないという問題があった。

【０００４】これに対して、誘導結合方式のプラズマ処理装置では、特願平１－３３８９００号に開示される様に、磁束に拘束される電子は低エネルギであり、イオンも低エネルギとなり、更に高密度プラズマを容易に生成することができ、被処理物に対する電子、イオンによる損傷も少なく、処理能力を大幅に向上することができるという利点がある。

【０００５】図4、図5に於いて、従来の誘導結合方式のプラズマ処理装置を説明する。

【０００６】金属製の真空容器１を設け、前記真空容器１の内壁面及び天井を覆う透磁性材料、例えば石英製のカバー２を前記真空容器１に嵌設する。該カバー２の天井上面に平板渦巻状に形成したコイル３を配設し、該コイル３の一端は第１高周波電源４に接続され、他端は接地される。前記真空容器１の下端を気密に閉塞する底板５には前記コイル３に対向配置され被処理物６が載置される処理台７が設けられ、前記処理台７は第２高周波電源８に接続されている。

【０００７】第１高周波電源４より前記コイル３に高周波電力が供給され、誘電結合によりカバー２内にプラズ

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マが発生し、該プラズマに高周波エネルギが供給される。誘電結合により発生したプラズマは異方性に欠ける為、前記第２高周波電源８より前記処理台７に高周波電力を印加し、高周波バイアスを発生させる。而して、前記被処理物６はプラズマからのイオンによりエッチングされる。

【０００８】

【発明が解決しようとする課題】然し乍ら、上記従来の誘導結合方式のプラズマ処理装置では、誘導磁界形成の為、平板渦巻状に形成したコイル３を使用しており、該コイル３で発生させたプラズマ密度を均一にするには、真空容器１の形状、被処理物６の大きさ、真空容器１と被処理物６との相関関係等に対して適正なコイルの形状、巻数とせねばならず、製作の都度膨大な実験を繰返してコイルの形状、巻数を決定していた。

【０００９】更に、コイルの仕様決定に於いて、コイルの巻数を多くするとインピーダンスが高くなり、必要な高周波電流を得るには高い電圧を必要とし、これに対応した高周波電力供給装置とコイル端末端子間の電気的絶縁が困難となる。従って高価な高周波電力供給装置となってしまう。

【００１０】更に、真空容器１が大きくなるとスパイラルコイルのインダクタンスが更に高くなる。この為巻数を少なくすると平板コイルの形状に応じた磁束密度分布となり、粗密分布差が激しくなる。プラズマ密度分布は該磁束密度分布に対応する為プラズマ振動を起し、プラズマが不安定となる。これは処理物上に電子を蓄積したり、被処理物６の薄膜生成時には膜質が均一とならない、という問題があった。

【００１１】本発明は斯かる実情に鑑み、誘導結合方式のプラズマ処理装置に於いて均一な高密度プラズマが容易に得られる様にしようとするものである。

【００１２】

【課題を解決するための手段】本発明は、被処理物に対向配置された平板コイルユニットに高周波電力を印加してプラズマを生成し、該プラズマを利用して前記被処理物を処理するプラズマ処理装置に於いて、前記平板コイルユニットを複数のコイルで構成し、或は更に複数のコイルそれぞれに電流調整手段を接続し、或は更に複数のコイルを高周波電源に対して並列接続したことを特徴とするものである。

【００１３】

【作用】平板コイルユニットを複数のコイルで構成することでインピーダンスを大きくすることなく磁束密度を高めることができ、更に磁束密度分布の均一化が図れ、更に各コイルそれぞれに流れる電流調整が可能となり、各コイル毎の磁束発生状態の調整が可能で、均一な高密度プラズマを容易に得ることができる。

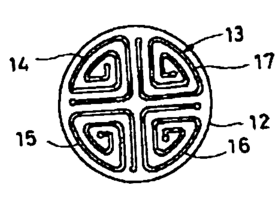
【００１４】

【実施例】以下、図面を参照しつつ本発明の一実施例を

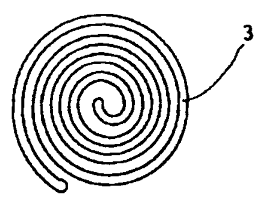
説明する。
【0015】真空容器１０の底部には処理台１１が気密に設けられ、該処理台１１には被処理物６が装填される。前記真空容器１０の天井は石英、ガラス、及びアナルナセラミックス等の絶縁材料から成る天井板１２で構成され、該天井板１２の上面に平板コイルユニット１３を載設する。
【0016】該平板コイルユニット１３は複数の平板コイル１４，１５，１６，１７により構成され、各コイル１４，１５，１６，１７は天井板１２を４分割した扇形状の各平面内に配設され、それぞれ可変コンデンサ１８を介して第１高周波電源１９に並列接続されている。前記処理台１１はスイッチ２０を介して接地され、又前記処理台１１は直流阻止コンデンサ２１を介して第２高周波電源２２に接続される。
【0017】図中、２３は処理用のガスを導入するガス導入口、２４は排気口である。
【0018】第１高周波電源１９より前記平板コイルユニット１３に高周波電力を供給し、誘電結合により真空容器１０内にプラズマを発生させ、該プラズマに高周波エネルギを供給する。
【0019】前記処理台１１は被処理物６を処理する目的に応じてスイッチ２０をＯＮして接地し、或は第２高周波電源２２より高周波バイアスが印加される。
【0020】即ち、スイッチ２０をＯＮして接地した場合は、被処理物６に所要の薄膜が生成され、又第２高周波電源２２より高周波バイアスが印加された場合は被処理物６に成膜された薄膜のエッチングが行われる。
【0021】前記コイル１４，１５，１６，１７はそれぞれ微妙にインダクタンス値、プラズマ結合程度が異なる。前記可変コンデンサ１８の静電容量値を調整し、前記コイル１４，１５，１６，１７に流れる電流を変えることで、前記インダクタンス値、プラズマ結合程度を調整することができ、前記真空容器１０内のプラズマ密度を均一にできる。
【0022】更に、上記した様に真空容器１０の寸法が大きくなると、前記平板コイルユニット１３が大きくなるが、該平板コイルユニット１３は複数のコイル１４，１５，１６，１７によって構成されているのでインピーダンスが低下し、更に複数のコイル１４，１５，１６，１７を並列接続することで更にインピーダンスが低下する。而して、インピーダンス低下に起因するプラズマ振動を抑制できる。
【0023】更に又、真空容器１０内のプラズマ密度を測定して前記コイル１４，１５，１６，１７に流れる電流を前記可変コンデンサ１８で調整することで、複数のコイル１４，１５，１６，１７により発生する磁束強度を調整することができ、平板コイルユニット１３全体が形成する磁束密度を均一化することができる。而して、プラズマが乱れず安定な且均一なプラズマが得られる。
【0024】尚、平板コイルユニット１３の分割方法、コイルの配列は種々考えられ、例えば図３に示す様に中央に円状のコイルを配設し、その周囲に円弧状のコイルを配設する等である。
【0025】又、前記可変コンデンサ１８は電流を調整する手段であればよく、可変抵抗、コイル或はこれらの組合わせでもよい。
【0026】
【発明の効果】以上述べた如く本発明によれば、複数のコイルにより平板コイルユニットを構成しているので、磁束分布に粗密の差を発生することなくインピーダンスの低下が可能であり、プラズマ振動を抑制できると共に各コイルに供給する電流を調整することで均一な高密度プラズマが容易に得られる等の優れた効果を発揮する。
【図面の簡単な説明】
【図１】本発明の一実施例を示す概略立断面図である。
【図２】同前実施例の概略平面図である。
【図３】本発明の他の実施例を示す概略平面図である。
【図４】従来例を示す概略立断面図である。
【図５】同前従来例の概略平面図である。
【符号の説明】

６　被処理物
１０　真空容器
１３　平板コイルユニット
１４　コイル
１５　コイル
１６　コイル
１７　コイル
１８　可変コンデンサ
１９　第１高周波電源
２２　第２高周波電源

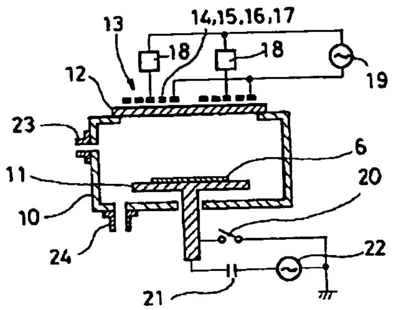
【図２】



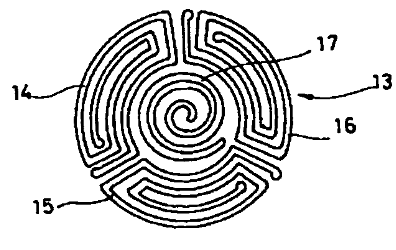
【図５】



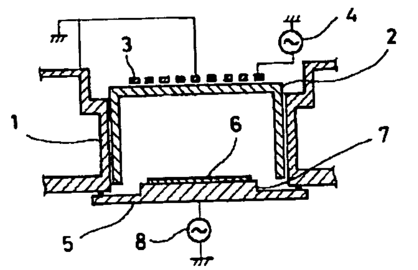
【図1】



【図3】



【図4】



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H01L 21/31		C		

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Variable Capacitors

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(22)Date of filing : 04.08.1994

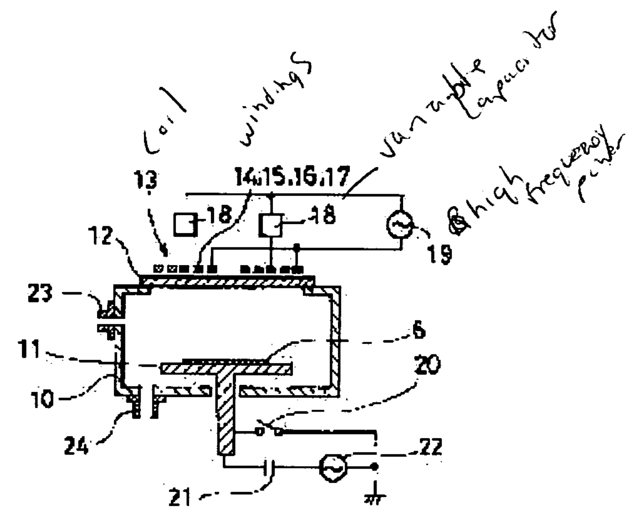
(71)Applicant : KOKUSAI ELECTRIC CO LTD

(72)Inventor : TAKAHASHI KIYOSHI
HAMANO KATSUTSUYA

(54) PLASMA PROCESSING DEVICE

(57)Abstract:

PURPOSE: To facilitate adjustment of each coil current as well as to increase flux density and to uniformalize the distribution of the flux density by composing a flat plate coil unit of plural coils.



CONSTITUTION: A plate coil unit 13 is composed by arranging plate coils 14, 15, 16, 17 on each of the fan shaped planes obtained by dividing a top plate 12 into four pieces and it is connected to a high frequency power supply 19 through a variable capacitor 18. In such a composition, the capacitance of a variable capacitor 18 is adjusted, an inductance value and the degree of plasma coupling are made adjustable by changing a current flowing through the coils 14-17, so that the uniformity of plasma in a vacuum container 10 is accomplished easily. Furthermore, the impedance is reduced by parallel connection of the coils so as to suppress the plasma oscillation caused by the impedance, thereby a stable and uniform high density plasma can be obtained.

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[Date of request for examination] 24.07.2001

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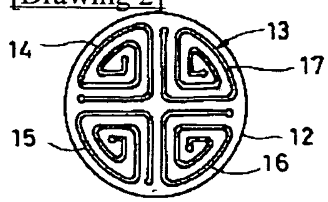
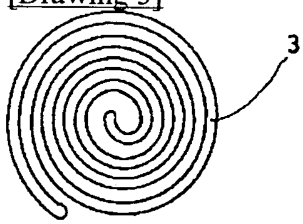
DRAWINGS

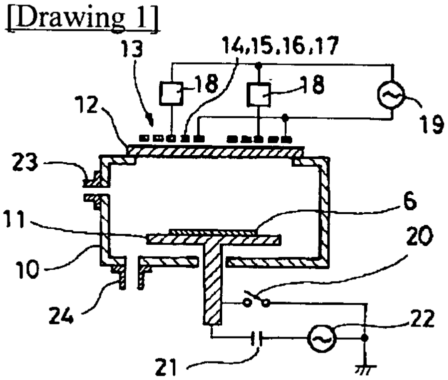
[Drawing 2]



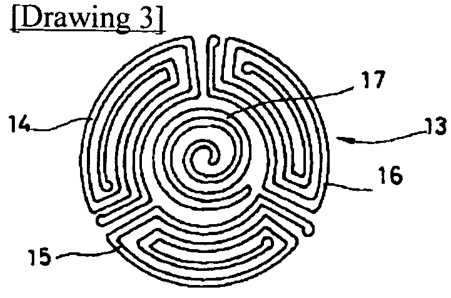
[Drawing 5]



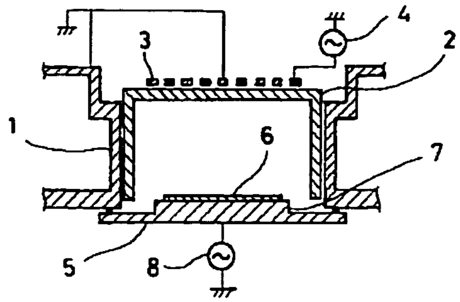
[Drawing 1]



[Drawing 3]



[Drawing 4]



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CLAIMS

[Claim(s)]
[Claim 1] Plasma treatment equipment characterized by constituting the aforementioned monotonous coil unit from two or more coils in the plasma treatment equipment which impresses RF power to a processed material at the monotonous coil unit by which opposite arrangement was carried out, generates plasma, and processes the aforementioned processed material using this plasma.
[Claim 2] Plasma treatment equipment of a claim 1 which connected the current adjustment means to two or more coils of each.
[Claim 3] Plasma treatment equipment of the claim 1 which carried out parallel connection of two or more coils to the RF generator.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention supplies RF power by inductive coupling, generates plasma, and relates to the plasma treatment equipment which manufactures a semiconductor device using the plasma.

[0002]
[Description of the Prior Art] RF power is supplied to a vacuum housing, plasma is generated, and there are an electrostatic capacity-coupling method and an inductive-coupling method in giving energy to plasma. A throughput large to the equipment processed using plasma, such as semiconductor fabrication machines and equipment and LCD equipment, in recent years is searched for, it comes and the high density of the plasma to generate is demanded.
[0003] The typical composition of the plasma treatment equipment of the electrostatic coupling scheme shown above impresses RF power between the parallel plate electrodes by which confrontation arrangement was carried out, and with the plasma formed between parallel plate electrodes, since the ion and electron of a high energy in plasma reached on a processed material by RF electric field, it was accepted and it had the problem which does an injury to a processed material that the contamination from a foolish Rika electrode could not be escaped, either.
[0004] On the other hand, with the plasma treatment equipment of an inductive-coupling method, the electron restrained by magnetic flux is low energy, ion also serves as low energy, and can generate high-density plasma easily further, and has the advantage that there can also be few injuries by the electron and ion to a processed material, and can improve a throughput sharply so that it may be indicated by Japanese Patent Application No. No. 338900 [one to].
[0005] In drawing 4 and drawing 5 , the plasma treatment equipment of the conventional inductive-coupling method is explained.
[0006] The metal vacuum housing 1 is formed and the covering 2 made from wrap permeability material, for example, a quartz, is fixed on the aforementioned vacuum housing 1 for the internal surface and ceiling of the aforementioned vacuum housing 1. The coil 3 formed in the ceiling upper surface of this covering 2 monotonously spirally is arranged, the end of this coil 3 is connected to 1st RF generator 4, and the other end is grounded. The processing base 7 in which opposite arrangement is carried out at the bottom plate 5 which blockades the soffit of the aforementioned vacuum housing 1 airtightly at the aforementioned coil 3, and a processed material 6 is laid is formed, and the aforementioned processing base 7 is connected to 2nd RF generator 8.
[0007] RF power is supplied to the aforementioned coil 3 from 1st RF generator 4, plasma occurs in covering 2 by dielectric combination, and RF energy is supplied to this plasma. Since the plasma generated by dielectric combination lacks in an anisotropy, from 2nd RF generator 8 of the above, it impresses RF power to the aforementioned processing base 7, and generates RF bias. It ** and the ion from plasma **********s [the aforementioned processed material 6].
[0008]

[Problem(s) to be Solved by the Invention] however, with the plasma treatment equipment of ** et al. and the above-mentioned conventional inductive-coupling method In order to make uniform plasma density which was using the coil 3 formed monotonously spirally for induction field formation, and was generated with this coil 3 It had to consider as the configuration of a proper coil, and number of turns to the configuration of a vacuum housing 1, the size of a processed material 6, the correlation of a vacuum housing 1 and a processed material 6, etc., the huge experiment was repeated at every manufacture, and the configuration of a coil and number of turns were determined.
[0009] Furthermore, in the specification determination of a coil, if the number of turns of a coil are made [many], high voltage will be needed for an impedance becoming high and obtaining the required high frequency current, and the electric insulation between the RF power supply corresponding to this and an end-winding end child will become difficult. Therefore, it will become an expensive RF power supply.
[0010] Furthermore, if a vacuum housing 1 becomes large, the inductance of a spiral coil will become still higher. If number of turns are lessened for this reason, it will become the flux density distribution according to the configuration of a monotonous coil, and an of-condensation-and-rarefaction distribution difference will become intense. Since plasma density distribution corresponds to this flux density distribution, it causes plasma oscillation, and it becomes unstable [plasma]. There was a problem that this did not accumulate an electron to a processing lifter, or did not become uniform [membraneous quality] at the thin film generate time of a processed material 6.
[0011] Uniform high-density plasma tends to be [in / the plasma treatment equipment of an inductive-coupling method / in view of this actual condition / in this invention] made to be acquired easily.
[0012]
[Means for Solving the Problem] this invention is characterized by having impressed RF power to the processed material at the monotonous coil unit by which opposite arrangement was carried out, having generated plasma, and having constituted the aforementioned monotonous coil unit from two or more coils in the plasma treatment equipment which processes the aforementioned processed material using this plasma, having connected the current adjustment means to further two or more coils of each, or carrying out parallel connection of further two or more coils to a RF generator.
[0013]
[Function] Flux density can be raised without enlarging an impedance with constituting a monotonous coil unit from two or more coils, equalization of a flux density distribution can be attained further, the current adjustment which flows in each of each coil further becomes possible, adjustment of the magnetic-flux generating state for every coil is possible, and uniform high-density plasma can be acquired easily.
[0014]
[Example] Hereafter, one example of this invention is explained, referring to a drawing.
[0015] The processing base 11 is airtightly established in the pars basilaris ossis occipitalis of a vacuum housing 10, and this processing base 11 is loaded with a processed material 6. The ceiling of the aforementioned vacuum housing 10 consists of crown plates 12 which consist of insulating materials, such as a quartz, glass, and announcer Luna ceramics, and fixes the monotonous coil unit 13 on the upper surface of this crown plate 12.
[0016] This monotonous coil unit 13 is constituted by two or more monotonous coils 14, 15, 16, and 17, each coils 14, 15, 16, and 17 are arranged in each flat surface of the shape of a sector which quadrisected the crown plate 12, and parallel connection is carried out to 1st RF generator 19 through the variable capacitor 18, respectively. The aforementioned processing base 11 is grounded through a switch 20, and the aforementioned processing base 11 is connected to 2nd RF generator 22 through the DC-blocking capacitor 21.
[0017] The gas inlet into which 23 introduce the gas for processing, and 24 are exhaust ports among drawing.
[0018] From 1st RF generator 19, RF power is supplied to the aforementioned monotonous coil unit 13, plasma is generated in a vacuum housing 10 by dielectric combination, and RF energy is supplied to this plasma.

[0019] The aforementioned processing base 11 switches on and grounds a switch 20 according to the purpose which processes a processed material 6, or RF bias is impressed from 2nd RF generator 22.
[0020] That is, when a switch 20 is switched on and grounded, a necessary thin film is generated by the processed material 6, and when RF bias is impressed from **** 2 RF generator 22, etching of the thin film formed by the processed material 6 is performed.
[0021] As for the aforementioned coils 14, 15, 16, and 17, an inductance value differs from a plasma combination grade delicately, respectively. The electrostatic capacity value of the aforementioned variable capacitor 18 is adjusted, by changing the current which flows in the aforementioned coils 14, 15, 16, and 17, the aforementioned inductance value and a plasma combination grade can be adjusted, and plasma density in the aforementioned vacuum housing 10 can be made uniform.
[0022] Furthermore, since this monotonous coil unit 13 is constituted by two or more coils 14, 15, 16, and 17 although the aforementioned monotonous coil unit 13 becomes large if the size of a vacuum housing 10 becomes large as described above, an impedance falls, and an impedance falls further by carrying out parallel connection of further two or more coils 14, 15, 16, and 17. It ** and the plasma oscillation resulting from an impedance fall can be suppressed.
[0023] Furthermore, the magnetic-flux intensity generated with two or more coils 14, 15, 16, and 17 can be adjusted by adjusting the current which measures the plasma density in a vacuum housing 10, and flows in the aforementioned coils 14, 15, 16, and 17 again by the aforementioned variable capacitor 18, and the flux density which the monotonous coil unit 13 whole forms can be equalized. **(ing) -- plasma -- not being confused -- stable ** -- uniform plasma is acquired
[0024] In addition, various the division methods of the monotonous coil unit 13 and arrays of a coil are arranging a circle-like coil in the center, as it thinks, for example, is shown in drawing 3 , and arranging a circular coil in the circumference etc.
[0025] Moreover, variable resistance, coils, or these combination are [that what is necessary is just a means to adjust current] sufficient as the aforementioned variable capacitor 18.
[0026]
[Effect of the Invention] While the fall of an impedance is possible, without generating the difference of roughness and fineness in a magnetic-flux distribution since two or more coils constitute the monotonous coil unit according to this invention as stated above, and being able to suppress plasma oscillation, the effect which was [acquire / easily / uniform high-density plasma] excellent in adjusting the current supplied to each coil is demonstrated.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is outline ******** showing one example of this invention.
[Drawing 2] It is the outline plan of this forward example.
[Drawing 3] It is the outline plan showing other examples of this invention.
[Drawing 4] It is outline ******** showing the conventional example.
[Drawing 5] It is the outline plan of this forward conventional example.
[Description of Notations]
6 Processed Material
10 Vacuum Housing
13 Monotonous Coil Unit
14 Coil
15 Coil
16 Coil
17 Coil
18 Variable Capacitor
19 1st RF Generator
22 2nd RF Generator

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